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REVIEW OF DECONTAMINATION SHOWER UNIT TESTS AND PLANS

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OBJECT OF PROJECT

To develop decontamination equipment for bacteriological warfare passive defense.

OBJECT OF SUBPROJECT

To develop a portable decontamination shower unit for field use and to investigate the possibility of recirculating waste shower water to conserve water supply.

OBJECT OF THIS REPORT

Interim report to review progress to date and to indicate plans to overcome difficulties encountered in waste water treatment.

RESULTS

Good success with BW and radiological simulants was noted but the unit is expensive, and poor results on recirculation with CW agents has been predicted by Army Chemical Warfare Laboratory. One new approach and two alternatives to the existing approach are suggested.

SUMMARY

The Bureau of Yards and Docks asked the Laboratory to develop a portable arctic decontamination shower unit incorporating a waste water treatment and a recirculation system. An experimental unit was devised using sedimentation and chlorination as a basis of the waste treatment. This system was tested with a biological warfare simulant and a radioactive fall out simulant with favorable results. No testing was done with chemical warfare simulants but technical information was received from the Army Chemical Warfare Laboratory which indicates that this simple waste treatment scheme was not adequate for chemical warfare use. In this interim report the test data and the technical information are summarized and problems associated with various applications are discussed.

In view of the technical difficulties and the expense of a shower unit it is believed that an individual decontamination kit should be pursued as a solution to these problems at the same time that CW treatment or fresh water storage for use with a shower unit are being investigated.

INTRODUCTION

Navy personnel constructing, operating, and maintaining advanced bases and shore establishments might be contaminated by chemical, biological, and radiological agents in the event of an enemy attack. To minimize possible personal injury from these agents, it is desirable that emergency decontamination shower facilities be provided for all personnel. Project NY 300 010-4, "Portable Arctic Decontamination Shower Unit", directs the development of a lightweight, portable, shower assembly for decontamination of personnel exposed to CBR warfare agents. Development of an experimental unit embodying these features was undertaken by this Laboratory. Because of the probable scarcity of an adequate water supply under Arctic and CBR warfare conditions, an investigation of the practicability of treating and reusing the shower water was included. This report summarizes the results of testing and investigating the shower waste treatment for all types of contamination and proposes a plan of approach for solution of the problems involved in CW decontamination.

DECONTAMINATION REQUIREMENTS

In the event of CBR contamination, the prime requirement would be rapid removal of the contaminant from the skin to reduce the chance of injury. The time available for decontamination would depend considerably on the type of contamination. A bacterial contaminant would generally cause no direct harm but its removal would be necessary to avoid the possibility of the organisms being inhaled, penetrating a skin break, or being taken into the mouth accidentally. Chemical and radiological agents may cause immediate and continuing damage and must be removed as soon as possible. To be most effective, a shower unit must be capable of being placed in service in less than an hour. With some types of CW agents this provides only a secondary decontamination since immediate measures are necessary with some agents to allow survival.

The amount of contamination that would actually reach the skin of an individual would depend on the amount and type of clothing worn. It is assumed, however, that many persons would be sufficiently contaminated to require a shower and fresh clothing. The amount of effort required to remove typical contaminants varies and ranges from washing with clear water to special medical treatment, but a decontamination shower using soap and water would be adequate in most instances. In some cases, a second pass through the shower would be required to remove radiological contamination on an individual. Accordingly, it was decided to design an experimental portable decontamination shower unit capable of providing a 4-min. shower.

DESCRIPTION OF UNIT

The experimental unit used in these tests consisted of three major components: the shower shelter, the water heating and treatment section mounted on a pallet, and an engine generator set to supply electrical power. The three sections could be loaded on a flat bed trailer for transport (see Figure 1).

The shower shelter was based on a rigid center frame with a skid base. Canvas was used for the walls and roof. To open the shelter from its collapsed position, the floor panels were folded down and a metal frame was set up to support the canvas. The water supply section consisted of a 150-gal water tank, a pump, and an oil-fired instantaneous water heater with thermostatic control. The water tank provided chlorine

reaction time. A glass wool scum filter was placed across the tank ahead of the pump inlet to minimize the amount of scum circulated. Three shower heads were located in the shower shelter.

WATER TREATMENT FOR RECIRCULATION

The waste water treatment scheme of the unit was kept as simple as possible to minimize cost and operation problems. Mainly, heavy chlorination was the treatment provided. The contact tank allowed 10 to 15 min. reaction time for the chlorine. Decontamination bleach was used for chlorination and a residual of 10 to 15 ppm was considered the minimum for sanitation. Higher values could be used for biological decontamination. Since decontamination bleach normally raises the pH to a point at which the chlorine acts slowly, it was necessary to use acid to keep the value just below seven, the desired range for BW decontamination. Litmus paper was used to test for pH and a color comparator type of device for chlorine residuals by the drop dilution method.

The 150-gal chlorine contact water tank also allowed for sedimentation of dirt particles. The glass wool filter across the tank ahead of the pump inlet served to reduce the amount of scum circulating and removed some particulate matter.

RECIRCULATION EXPERIMENT WITH BACTERIOLOGICAL CONTAMINATION

The effectiveness of the chlorination procedure for biological disinfection of the water to be recirculated was tested[1] by Fort Detrick personnel. Untreated water and soapy water were contaminated and circulated as a control test and large numbers of the test organisms, *Bacillus globigii* and *Serratia marcesecens*, survived to recirculate. However, when a chlorine concentration of greater than 10 ppm was maintained in the circulating water at a pH of 6.7 none of the test organisms survived passage through the contact tank.

RECIRCULATION EXPERIMENT WITH RADIOACTIVE CONTAMINATION

A simple recirculation test[2] was made at the Naval Radiological Defense Laboratory to explore the problems involved and to determine whether recirculation might be possible with radiological contamination. The unit was set up

for operation in an experimental area to simulate field service. Operation was without test subjects, but soap was added to the waste water in an amount to approximate that which would actually be used by personnel. The thermostat was set to maintain a water temperature of 90 degrees Fahrenheit and a chlorine residual in excess of 50 ppm was maintained. Acid was used to keep the pH down.

It was calculated from the showering rate of one man per min and fallout information that 4 grams per min of synthetic fallout should be added to the system during the operation period. The material used had a specific tracer activity of 2.5×10^{8} counts per min per gram resulting in a total feed of 10^{9} counts per minute. Samples of the recirculated shower water were taken periodically and the gamma radiation activity was measured in counts per min from 5 ml portions.

Table 1 lists the total counts per min added radioactivity per 5 ml of water during the test period and the counts per min of built up radioactivity in the 5 ml portions of shower water over the same period of time. The removal percentage range was over 99 per cent. At the end of the test period approximately 0.0001 of the tracer activity added was carried in the shower water indicating that the fallout simulant had been largely deposited in the water system. Table 2 lists the locations where the activity was deposited. Much of the contaminant never left the waste sump to which it was fed (see Figure 2). Other points of concentration were the scum and scum filter.

The effectiveness of the waste water treatment in removing fallout simulant was much greater than had been expected and indicated that the simulant settled out readily. The concentration of radioactivity in the shower sump to form a 30 milleroentgens per hr radiation source indicated that special precautions may be necessary to minimize exposure of operating personnel when a more highly radioactive contaminant is involved.

CW DECONTAMINATION PROBLEMS

Because of the lack of CW agent handling equipment at NAVCERELAB, the Army Chemical Warfare Laboratories[3] were contacted for technical advice on the suitability of the treatment scheme to adequately detoxify shower waste water containing quantities of the various agents that might wash off affected personnel. After some indication that chlorination

might be adequate it was determined that the slowness of some agents to hydrolyze in the waste water might mean that unreacted agents would be returned to the showers. Additionally, the reaction products of some agents with chlorine are sufficiently toxic to be nearly as dangerous as the original agent. Detection methods for certain agents also require considerable time and the contact time would have to be more than doubled to allow a check of the safety of the recycled water. The holding period to allow such a test would be about 25 min, so that allowing additional time for contact with the chlorine prior to holding would mean that a 35 to 40 min operational water storage capacity would be necessary. For the 60 man per hr unit this storage would be about 400 gal under the present method of operation.

EQUIPMENT PROBLEMS

The equipment tested proved fairly satisfactory for providing a shower shelter, and for water heating and pumping. However, much needs to be done to improve the portability and economy of this equipment.

An investigation of available Seabee construction equipment has showed that a standard bitumen melting kettle can be modified to handle the water treating, heating, and pumping requirements. This equipment was trailer mounted and was less expensive than the equipment pallet used in the experimental unit. Other field equipment was available to provide shelter and space at a relatively low cost.

DISCUSSION OF PROBLEMS

The primary problem of the basic design of the unit as developed so far is the inadequacy of the treatment system to handle CW wastes. However, even before the recirculation scheme is used for AW or BW wastes there must be further testing for these conditions, since the tests reported so far are exploratory in nature. Before further testing of these aspects is undertaken, resolution of the CW problem is essential.

The problem of devising a treatment system capable of handling all of the various CW agents that might be involved is imposing within the limitations of a simple portable field unit. Just the time required for detection tests makes a sizeable increase in the holding capacity of

the unit. The best potential means of CW waste treatment is activated carbon adsorption and this type of treatment can be accomplished in two different ways, either by filtration through a granular bed or by addition of a powdered material to the water. The added material must be subsequently removed. Filtration is complicated by the necessity of prefiltration to remove solids and soap scum which will almost immediately clog the fine capillaries which provide the adsorption surface of the carbon. Use of the powdered material would involve a complicated system to remove this fine material after it has gone through the contact tank. More specific data is needed on the required treatment of CW wastes, however, before the possibilities are discarded completely.

Considering that the quantity of water necessarily involved in allowing CW detection tests approaches that used in a 40-min interval and that the likely useful operation time is probably only in the range of 90 to 120 min, the alternative of adding storage capacity to allow for 90-min operation seems at this time to be the most profitable approach to a satisfactory shower unit. With the present unit design the stored water would be most conveniently handled in an auxiliary water trailer. The water could be drawn by the shower unit pump as required for delivery through the heater to the showers.

Since the original design of the circulation systems called for a constant flow shower spray, some reduction in the water quantity required was made by using spring-closing shower heads. This did not interfere with the effectiveness of the showering and reduced the quantity of water used by about two-thirds, but added some problem in controlling the water temperature. Adopting this method reduced the quantity of fresh water required per individual to about 3 gallons. Thus, a unit capable of handling about 60 men per hr for 2 hr would require about 400 gal of stored water, which is the capacity of an ordinary water trailer.

The components of a field unit so developed would be a water trailer, equipped with a pump and heater, miscellaneous piping and hoses, a canvas shelter, and a shelter heater. Of necessity, the water trailer would require a heated storage shelter in arctic areas, but the 60 man per hr unit also requires heated shelter for the 150 gal needed to start up. The increase in heated shelter for the larger unit does not appear excessive.

Another alternative to the unit tested would be to use an individual decontamination kit consisting of a cleansing solution, rinse water in a 1-1/2 gal can, a sponge, towel, and fresh clothing if considered desirable. The primary advantage of having a quantity of such kits stored for emergency use, should several hundred persons have need for decontamination facilities, would be to have them ready for use at one time. For cold weather a heated shelter would be needed but this would be less of a problem than attempting controlled sequence showering of several hundred persons, all of whom wanted to get showered first.

Such a kit could undoubtedly be devised to cost about $5 per person plus the cost of any clothing included. Comparing this to a cost of about $3500 for a 60-man per hr unit ($70 per person if 500 persons are cleansed in the unit), the decontamination kit possibilities become even more favorable. In the event that no transportation was available, the troops could carry their individual kits to a clean area to proceed with the decontamination without dependence on motor transport which in certain types of terrain, such as arctic summer muskeg, might be impossible.

Depending on the effectiveness of the cleansing solution developed for use in the individual kit, the principal disadvantage of this idea is the possible lack of good cleaning if the individual does not take sufficient time to do a good job. With the sequenced shower there is better control over the individual effort, but with appropriate forewarning individuals in either case should be reasonably interested in doing a good cleaning job.

CONCLUSIONS AND RECOMMENDATIONS

The three systems discussed in this report, (1) recirculated shower water, (2) storage of shower water, and (3) individual kits, all have some merit. Further investigation of the CW waste treatment is required if recirculation is to be allowable. In view of the probable complication of this treatment, the redesign of the experimental shower unit for operation with storage water and investigation of the individual decontamination kit seem necessary. When the experimental shower unit is redesigned it should be made less expensive and use as many standard catalogue items as possible.

REFERENCES

1 - NAVCERELAB Technical Report TN-218, Development of a Portable Decontamination Shower Unit, W. R. Nehlsen, S. Giles, and E. Hellberg, 25 April 1955.

2 - NAVCERELAB Technical Report TN-281, Radiological Test of Decontamination Shower Waste Water Recirculation, W. R. Nehlsen, 4 October 1956.

3 - BUDOCKS letter D-442 A/ewm, NY 300 010, A16-11/L5, Ser: 07310 of 26 July 1956.

Table 1. Shower Water Radioactivity Build-up

Time from start of test (min)	Total radioactivity added to shower sump per 5 ml water (cpm)	Radioactivity build-up in shower water (cpm/5 ml)
0	0	0
10	1×10^6	2.0×10^3
20	2×10^6	2.0×10^3
30	3×10^6	2.1×10^3
40	4×10^6	2.5×10^3
50	5×10^6	3.3×10^3
60	6×10^6	4.7×10^3
70	7×10^6	7.8×10^3
80	8×10^6	8.7×10^3
90	9×10^6	9.0×10^3
100	1.0×10^7	9.6×10^3
110	1.1×10^7	1.05×10^4
120	1.2×10^7	1.15×10^4
130	1.3×10^7	1.3×10^4
140	1.4×10^7	1.45×10^4
150	1.5×10^7	1.68×10^4

Table 2. Radiation Survey of Shower Unit After Recirculation Test

Location	Radiation
Open water tank	2 to 10 mr/hr
Simulant feeder location	30 mr/hr
Outside tent north side	1 mr/hr
Floor by tank	0.8 mr/hr
Outside tent west side	0.1 mr/hr
Inside tent west side, over air intake screen	0.1 mr/hr
Inside tent floor shower corridor	1 mr/hr
Inside tent roof shower corridor	0.1 mr/hr
Inside above shower air intake	0.2 mr/hr
Inside tent drain gutter shower	0.7 mr/hr
Inside tent east side floor	0.4 to 2.0 mr/hr
Inside tent air intake above shower (east side)	0.4 mr/hr
Inside tent southeast side floor near curtain	0.15 mr/hr
Inside tent southeast side rest of floor	less than 0.1 mr/hr
Inside tent air intake screen	0.2 mr/hr
Outside tent east side (through canvas)	0.1 to 0.3 mr/hr
Top of tent (center-wood wall)	0.25 mr/hr
Stack inside	less than 0.1 mr/hr

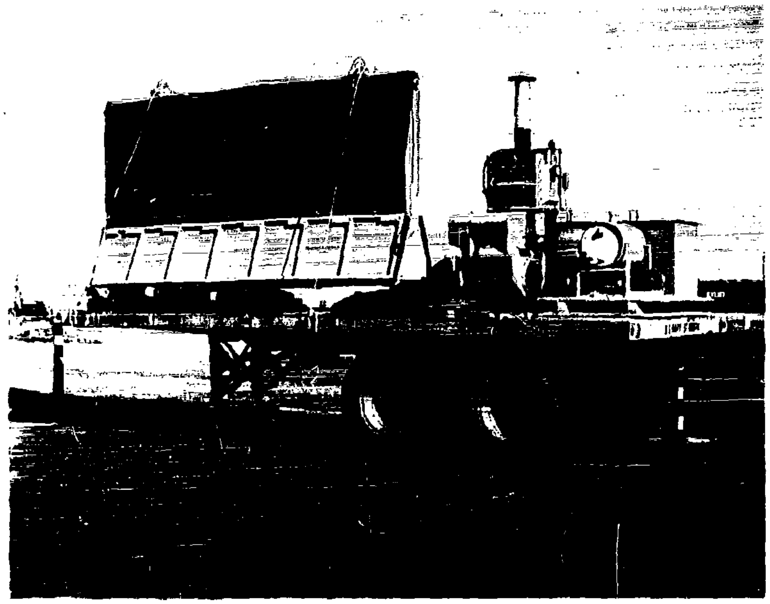

Figure 1. Shower unit loaded for transport.

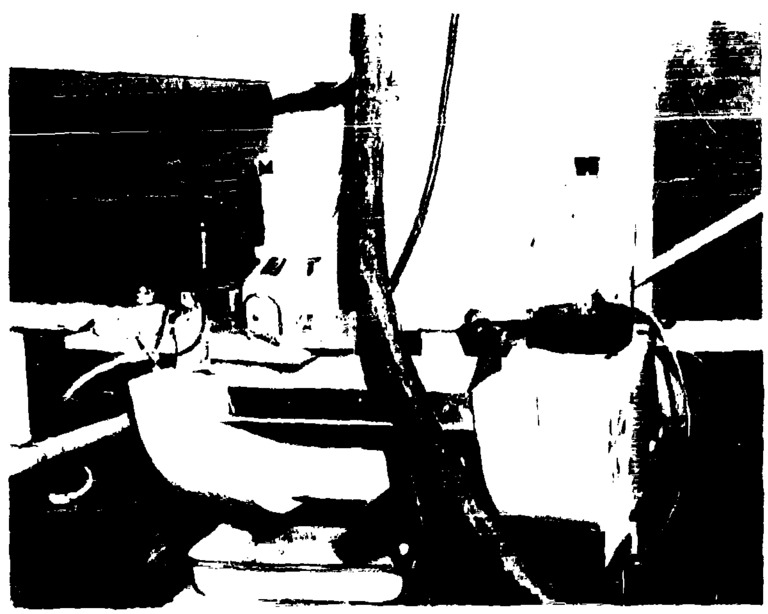

Figure 2. Fallout simulant and soap being fed to shower waste sump.